To MACT and Beyond

Anticipating new MACT standards, a new system would be required.

By John Enhoffer

In the 1970s, FMC Corp., a chemical manufacturer headquartered in Philadelphia, began operating a high-efficiency thermal destruction facility to dispose of hazardous liquid wastes at its Baltimore pesticide manufacturing plant. The facility used a thermal oxidizer with a rapid quencher and packed tower scrubber to remove air pollution emissions. The system was upgraded in the early ’80s and configured with a thermal oxidizer, flue gas quenching stage, condensing section, a wet electrostatic precipitator (WESP) and induced draft fan.

In 2000, the company recognized that, while the system was meeting existing EPA standards, it was nearing the end of its useful life. The company hired combustion and environmental technology consultant, Rick Ullrich of WastePro Engineering Inc., Kennett Square, Pa., to research cost-effective alternatives that would enable it to meet or exceed anticipated new EPA maximum achievable control technology (MACT) standards.

After evaluating liquid hazardous waste disposal alternatives, FMC found that Mahwah, N.J.-based Bionomic Industries’ unique wet scrubbing system would provide the most efficient EPA-compliant solution at one third the cost of a new WESP.

The new system, which has been operating flawlessly for three years, has enabled the plant to achieve particulate outlet loadings of under 0.003 grains per dry standard cubic foot (grs/dscf) – approximately five times better than the EPA’s MACT standards – even when, for compliance and evaluation testing, the ash content of the oxidizer feed was purposely spiked. The installation of a gas reflux draft control system, or GRDCS, provided constant control of the oxidizer draft without operator intervention to within 0.1 inches w.c.

Evaluating options

“We reviewed proposals from seven suppliers, which included replacing the WESP, rebuilding it, eliminating it and installing a venturi or hydrop scrubber.” said Ullrich. “After comparing the cost and performance of each option, we recommended that FMC install Bionomic Industries Series 7000 Gas Atomized Venturi Scrubber because it is a well-established technology and presented no technical risk. We determined that this option would provide compliance with the interim MACT standard and maximum flexibility if high ash content wastes returned, or the interim standard was further tightened.

“Additionally, the venturi scrubber can capture salt particulate, which had been a problem in the past with the WESP, and provide savings of $100,000 per year. The technology fit with a future WESP rebuild or replacement, driven by either a tighter PM standard or heavier ash loading. The scrubber’s cost was less than the WESP rebuild and we believed that some WESP components would be useful in a venturi design, reducing capital expenditure by as much as $250,000. The combination of increased horsepower requirement but reduced water usage (over the current WESP) will increase overall thermal oxidizer operating costs by less than $25,000 per year.

“If the final MACT standard for PM is lowered ... we can review rebuild versus replace WESP options. By installing the venturi, the company is assured that, should the standard be lowered, capital cost for modifications are minimized.”

Thermal oxidizer operation: pre-venturi

The RCRA-permitted hazardous waste thermal oxidizer burned organic waste liquids with low levels of metals, moderate levels of ash,

Above is the venturi and chevron separator assembly. The stack in the middle is the old WESP.

and high levels of chlorine. The gas cleaning equipment upstream of the WESP started with a quench, operating with a co-current flow of fresh water. Downstream of this was a packed tower scrubber, with cooled, recirculated water flow. A purge of the commingled, neutralized water streams from these vessels kept salt levels from building beyond 3 percent. Freshwater makeup flowed to the quench sprays to minimize PM entrainment.

Ullrich’s studies showed that inlet loading ranged from 0.003 to 0.030 grs/dscf (corrected to 7-percent oxygen) depending upon the feed matrix. It determined that this variability could be reduced somewhat, and corresponded to 0.2- to 3.0-pounds per hour (pph) PM. Allowable emissions under the future MACT standard (0.015 grs/dscf corrected to 7-percent oxygen) were approximately 1.6 pph at maximum flow rate.

Maximum gas flow had been reduced to 25,000 acfm, while typical flow was 15,000 acfm. The study also showed that further increases in thermal oxidizer production possibly could be achieved in this flow range, with higher operating temperatures (and moisture content).

Based on his findings, Ullrich recommended replacing the existing ID fan, and installing a venturi scrubber between the packed tower and fan. The ability to operate the venturi system at a higher pressure drop, with future inlet loading as high as 10-pph PM, and still meet the 0.015 grs/dscf standard, became a major design objective.

The induced draft fan is shown in the above photograph.

Harnessing FFC technology

"We suggested that FMC retain as much of the existing system as possible, but harness flux force condensation (FFC) technology to control the fine particulate emission," said Ken Schifftner, a sales manager for the venturi scrubber manufacturer. "In an industrial environment, FFC technology reproduces what happens in the atmosphere when water vapor condenses on particulate and forms rain. Taking a hot, humid gas stream and sending it through a shower of cold water causes submicron particulate to serve as nuclei around which water vapor condenses forming larger droplets. Since these larger droplets are easier to capture than the submicron particulate, the removal efficiency of the gas cleaning system is enhanced.

"Flux force pertains to the temperature difference between the hot humid gas stream and the cold liquid surface. The hot vapor tends to migrate toward the colder surface induced by the temperature difference, similar to a fog forming on a cold bathroom mirror."

To improve gas cooling, Ullrich suggested that the facility modify its existing condensing units to improve gas cooling, and take the WESP offline and use it as a piece of ductwork. A new venturi scrubber was used to capture the enlarged particulate droplets. A special dual-stage, horizontal gas flow chevron droplet eliminator stage was used to remove residual droplets. The venturi throat internals were made from alloy C-276 and the scrubber vessel was made from fiberglass reinforced plastic, as per the company's strict specification.

Improved combustion efficiency

Another significant improvement was made to address operators' concerns about difficulties with draft control on the oxidizer. With the former system, the ash content and heat release rate during combustion might quickly change, affecting the instantaneous amount of flue gas products. Combustion efficiency could be improved if the draft could be controlled more precisely.

The scrubber manufacturer recommended a gas reflux draft control system to provide an automatic draft control system on the oxidizer. The system incorporated a draft sensor to constantly monitor the oxidizer outlet plenum for any changes in draft, however subtle.

The signal from the sensor was configured to modulate an opposed-blade damper mounted in the gas reflux line, which connected the stack with the inlet of the scrubber. This operation dumped a regulated amount of previously scrubbed, clean gases back to the venturi

Above is shown the feed duct with the venturi upper section with an adjustable throat.

inlet, thus maintaining the oxidizer draft and improving gas cleaning. The venturi scrubber was purposely oversized to allow a portion of these gases to be returned under nearly all conditions.

"We are very pleased with the system's performance since we reduced our emissions with a piece of equipment that was less expensive and less difficult to operate," said Kurt Krammer, the facility's environmental manager. "Its performance has actually exceeded design expectations. Not only has the system been operating exceedingly well for two years, but because its proven capability and flexibility, we are confident that it will enable us to meet even the most extreme version of the MACT standard that may set without modifications." **PE**

For more information, contact John Enhoffer, president of Bionomic Industries Inc., at (201) 529-1094 ext.11 or jenhoffer@bionomicind.com.

Visit www.pollutionengineering.com and electronically forward a copy of this article to a colleague or customer.